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ABSTRACT

Institutional research and the role of information systems are examined and three types of information provided by institutional research offices are discussed: institutional studies, management analyses, and periodic management reports. The varying characteristics of research offices are described and the role of the institutional research office in the decision-making process is examined. It is noted that increasingly the large, computerized information systems are the principal source for information and dominate administrative data processing. Specific functions of these systems are discussed and it is emphasized that integrated information systems may be the most useful for higher education institutions. Various impacts of information systems on institutional research are also reviewed, including issues of data quality, control of the system, and the degree of system integration. It is suggested that effective utilization of information systems centers on communication between processors and analysts. The need for institutional information systems to adapt to the rapidly changing climate of academe is emphasized. The role of on-line data base systems is discussed and the impact of state and national information systems is examined. It is concluded that for colleges and universities the institutional research office should become the planning system by maintaining an accurate, accessible, and integrated data base. (SF)

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DEALING WITH INFORMATION SYSTEMS: THE INSTITUTIONAL RESEARCHER'S PROBLEMS AND PROSPECTS

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Rapid developments of increasingly complex information systems are having considerable effect on institutional research. Institutional research offices are sophisticated users of computer systems as well as gatherers of data directly through questionnaires, surveys, and non-mechanized records. What is the impact of the increased use of computer systems on the practice of institutional research? What does the analyst need to look for in using information systems? What peculiar problems are presented in using someone else's data? What are the prospects for the future, given rapid technological change? Discussion of these and related questions requires a brief overview of the function of institutional research offices, the context in which they operate, and the data they use.

Functions of Institutional Research

Institutional research offices provide three kinds of information: institutional studies, management analyses, and periodic management reports. *Institutional studies* are detailed reviews of particular aspects of institutional activity and are often designed to answer questions raised by outside agencies such as accrediting bodies. *Management analyses* can be instigated either by the analyst or the institutional executive but are designed to answer questions of immediate importance to the institution and its managers. (How many faculty will retire in 1980? What is the impact of raising retirement age of faculty? If admissions requirements are raised 10% for freshmen, what will be the effect on the number of students admitted? How do faculty salaries compare with those of other institutions?) *Periodic management reports* are ongoing, regularly recurring reports such as those on faculty load, student credit hours taught, the cost of student credit hours produced, degrees granted, and students enrolled.

Constraints Surrounding the Institutional Research Office

The institutional research office does not operate in a vacuum, and the reporting arrangements, lines of communication, and information flow vary substantially from institution to institution. In some institutions, institutional research offices are research centers located outside the administrative chain of deans, vice presidents, and president. These offices tend to concentrate on long-term studies and regular reporting. Their techniques and methodologies are derived from psychology and other social sciences, and their results are published often in various journals.

The institutional research office may also be located very near the president or provost and may be the central staff office for answering questions about the functioning of the institution. Proximity to top management insures a continuous flow of requests requiring rapid response.

In addition to the organizational location, it is important to know the particular climate surrounding the institutional research office. A characteristic of the institutional research unit located near the institutional executive is that its products are always needed yesterday. Institutional governance is sometimes characterized as organized anarchy, with executives moving from one crisis to another, with little or no time for reflection, planning, or studied decision making. Failure of the institutional research analyst to respond quickly in such a setting usually results in the executive turning to someone else for answers.

Another constraint on the institutional research function is that there is always a variety of problems and issues under consideration at any one time. An institutional research office in a large university may be considering tuition increases and faculty salaries, planning for enrollment downturns, reviewing new programs in the health sciences, answering legislative inquiries about what faculty do with their time, and doing all within a short period of time. The scope of questions requires the analyst to have access to a wide variety of information covering all aspects of the institution.

Decision-Making Style

Much of American higher education is characterized by a participative style of management in which governance is shared by faculty committees, faculty-administration task forces, faculty senates, governing boards, committees of deans, affiliated department chairmen, and advisory groups. Decision making tends to involve a number of groups. Some of these groups have formally designated powers and responsibilities so that particular proposals must be approved by them; faculty oversight of course and graduation requirements is an example. Other groups have fewer formal responsibilities or may be formed only for a special study, such as an ad hoc task force on campus parking problems. Some groups have a stable membership but a changing agenda, for instance an executive committee of faculty who advise the president on academic policy or budgetary matters.

The existence of a number of groups within an institution has several implications for the style of decision making and, hence, the style of analysis that is most viable. Many of the groups that are formally or informally consulted on a particular issue have little in the way of background information but usually have strong opinions about what the relevant variables or method of analysis may be.

Faculty members are automatically experts on the administration of an institution and may have particular "pet" approaches that they want incorporated in the analysis. The analyst must be prepared, then, to meet the demands of different audiences, to structure and restructure the analysis to take account of divergent points of view or to include new factors in the analysis. Faculty salaries, for instance, are of compelling concern to faculty groups. Faculty will usually have notions about an appropriate comparison group as well as appropriate methods of analysis. The analyst must be prepared to change comparison data to be sure that all appropriate institutions are included or to accommodate suggestions made by different faculty representatives. The kind of comparison—whether rank-by-rank averages, for continuing faculty, or new and continuing faculty, or aggregated averages, whether weighted rank by mix or not—will be of concern also. While it is helpful, initially, to spend time with all the advisory groups so that the preliminary analysis can be as complete as possible, it is impossible in most cases to anticipate every question in advance or

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include every permutation of the data. Operating in an environment in which the audience is changing its formulation of the question requires the analyst to have the ability to analyze and reanalyze the data in a variety of ways, often with little advance warning.

The institutional research analyst, as a result of the special work environment of institutional research, must work under great time pressure, must contend with a large volume of pressing concerns, each competing for attention, and must have access to and be knowledgeable about sources of information within and without the institution. The analyst must do all this rapidly, accurately, and with good humor.

Techniques of Institutional Research

The techniques and resources that the institutional researcher uses include statistical methods, information from institutional information systems and from other institutions, assembly of historical data, analytical methods derived from operations research and economic theory, and data gathered through questionnaires, surveys, and other direct methods.

Statistical techniques allow the analyst to analyze information and to determine its limits as well as its reliability. By drawing on small sample theory, regression analysis, and other tests, the analyst can answer the question How good are these data? or How can they be extended? This is vital for policy analysis purposes. A president, for example, needs to know how much to trust an estimate that enrollment will be 6% greater next year because institutional decisions of some magnitude hinge on the answer to that question.

Comparative information gathered directly from other institutions, or from nationally available data banks supported by large information systems, is an increasingly important tool for the institutional research analyst. Institutions do not exist in a vacuum, and comparisons of salaries, tuition and fees, enrollment trends, financial standings, and the quality of graduate programs are being made formally and informally. Knowledge of and access to national data banks about higher education is important in order to supply answers to questions about what other institutions are doing. Contacts with analysts at similar institutions, either formally or informally, permit the development of shared information not available nationally.

Historical data bases for the analyst's institution, as well as for other comparative institutions, are another resource in the analyst's repertoire. Regular management reports are often a part of the data bases of the institutional research office. These can be compiled and maintained so that questions about trends can be answered. Projection is difficult without adequate historical data bases, and routine review of trends is an essential part of management reporting.

Analytical and modeling methods are used to examine hypothetical questions: What if enrollment stays the same next year? What if a new program is added to the health profession area? What if most faculty choose to take early retirement? What if the trend towards vocational subjects continues? Institutional research offices have models of student demand for courses and translate these into requirements for faculty. Models of faculty entry and exit from the work force and student flow models are utilized also. Selection of the appropriate model and the choice of data to estimate the parameters of the model are steps in answering the "what if" questions.

Institutional research analysts, in both their research and policy analysis roles, have often gathered information directly from surveys, questionnaires, interviews, or Delphi instruments. Standard instruments have been developed for many topics, and survey research itself is now a specialized subfield within sociology. Techniques for developing and administering questionnaires to insure reliable results are highly developed, and can be obtained often from specialized firms or groups that exist to conduct survey research.

All of these techniques are dependent on information, and for the institutional research analyst, the principal source for information about the institution is, increasingly, the large, computerized information systems that dominate administrative data processing units at most campuses.

Characteristics of Computerized Information Systems

Given that much of the data used in institutional research analysis is processed by these large systems, what are the characteristics of computerized systems, and what is their impact on the kind of analysis that can be done, its accuracy, validity, and acceptability?

Most information systems used in our institutions are operational in nature, that is, they exist to serve specific day-to-day purposes. Payroll and personnel information systems exist primarily to process payroll checks and keep track of who is getting paid how much. Accounting systems have as a primary function keeping track of expenditures by budget category and the preparation of fiscal reports and annual statements. Budget systems exist to report the status of budgets, and equipment inventory systems record the location, value, and disposition of equipment. There are also a few systems which have as their primary purpose supplying management or planning information. (These will be discussed toward the end of the paper.) The bulk of the information used by the institutional research analyst comes from systems that were not designed with analytical or management problems in mind.

Institutional information systems are also complex. In their complexity they are rigid and formalized, with a set of procedures for entering data, a processing schedule that satisfies the principal operational user, and a set of standards for the operation of the system. Operational systems are usually well documented simply because they are operational, but their complexity may make them difficult to understand or manipulate.

Rigidity is associated both with the complexity and operational nature of most information systems. Because payroll checks need to be produced every month, or accounts balanced at the end of the year, or purchases paid for, the systems must be predictable and stable. The operational demands of the system do not permit frequent changes, and, once established, modifications can only be made in a systematic fashion so that the underlying work of the system is not compromised.

A rather unfortunate aspect of most institutional information systems is that they are unintegrated. Each system development project is a separate activity and, as new systems are added or old ones modified, the latest technological and processing innovations are introduced. Often, however, limits on the resources available do not permit systems designers to go back and update all the existing systems to reflect the latest technology and design innovations. Because operational systems are developed at different points in time, the data definitions carried on the various systems may vary substantially. There tends to be some overlap in the information that is recorded on systems, often with slight variations in definitions. Faculty appointments recorded on an academic personnel system may include persons who are appointed to faculty rank but who are not getting paid from the institutions, such as doctors who donate their time to medical schools or businessmen who give occasional lectures. Payroll counts do not include these "free" faculty. Thus, a count of faculty based on the academic personnel system will overlap but not agree with the count of faculty based on those individuals who are receiving paychecks from the institution.

Because systems are unintegrated, the analyst who aggregates data from several different systems faces trouble. A *department*, as defined on the budget system, is a collection of budget or account codes, while a department in the student registration system may be a collection of student major or course identifiers. A department for the physical space inventory

system is a collection of rooms, or even a building or two. Which department is the analyst to use, and how are the varying definitions to be reconciled?

An additional characteristic of institutional information systems that may cause trouble for the analyst derives from their operational nature—someone other than the analyst user controls the system. Not only does this mean that the system is seldom designed with the analyst's needs in mind, but access to the system is limited and the right to initiate changes is almost nonexistent. The operational aspect of the system must be maintained at all costs, and changes can be made only when they do not interfere with the operation. Also, the principal operational user must be convinced that the changes or additions sought by the analyst are important and necessary.

Impact on Institutional Research

How do these characteristics affect institutional research? The operational nature of the information system has, perhaps, the most direct impact on the potential uses of the data by the analyst. Data quality is a concern of both the analyst and the operational user. However, the concern with data quality is related directly to the operational purpose of the system. The payroll manager wants to be sure that checks in correct amounts are issued to appropriate persons and that the correct deductions are taken from gross pay and recorded in a systematic way. The payroll manager, though, may be less concerned about whether the address recorded on the payroll record is correct if the address is not used to distribute paychecks. Attempts by the analyst to use this address to study the transportation needs of institutional employees may be less than satisfactory. Or, the payroll record for an individual may have the person's highest degree earned entered when the individual is hired. An analyst who depends on that record to analyze salary by degree held may find that all degrees earned subsequent to employment have not been entered. The payroll manager is not concerned with correcting that information since it does not affect payrolls. Data quality is uneven in operational systems since there is a tendency for the operational manager to audit and review data only in those areas which affect the principal function of the system. Higher quality data exist when there is a built-in audit check. The payroll system, for instance, has such a check when employees receive their paychecks and see that the dollar amount is correct. The more peripheral data are to the central purpose of the system, the lower their quality tends to be.

Another aspect of an operational system which causes concern for the analyst has been alluded to in the discussion of the control of the system. Changes to operational systems are slow, time consuming, and difficult to make. The analyst often must face the question of whether it is worth the effort to get a system changed so that data quality can be improved. For most purposes, the data as reported on the operational systems are what the analyst has to work with and, given demands for rapid response, the analyst has no choice but to try somehow to adapt the existing data to fit the problem being examined.

The unintegrated nature of information systems means that considerable analytical effort is spent in trying to determine what is the most correct definition to use and which data system is the best source for the desired information. *Correct* really has two senses that are relevant for the analyst: in the most elementary case, the analyst needs data that have been accurately entered, updated, and recorded and which are processed correctly by computer programs. Incorrect data, in this sense, exist in every system, even when the analyst collects the basic data. A good analytical sense and a feel for the underlying realities being measured, as well as some experience with the results of similar kinds of analyses, are among the techniques the analyst must use to work with this problem.

A more serious kind of problem affects the user of unintegrated information systems. The institutional researcher is often one of the few persons in the institution who assembles data from a variety of information systems. Where systems are unintegrated, definitions often do not agree, and the analyst must decide how to fit the competing definitions together. An analyst, for example, may need to assemble an inventory of the physical space a department occupies to determine if there is adequate space for all faculty paid by the department. The physical inventory file may record the location of every class taught by the department, and the payroll may record all the faculty paid by the department budget; yet many institutions assign courses to the department offering the course, rather than to the department paying the faculty. If significant numbers of non-department faculty are teaching courses, the physical inventory may give a misleading picture of the square feet occupied by the faculty paid by the department. The potential link between the two systems—the definition of a department—is missing in both systems, and the analyst must supply it.

Since the systems were not constructed with potential analytical needs in mind, consistent definitions often cannot be used, and the analysis can only be approximate. Definitions used in an operational system may be appropriate to the needs of that system, and the operational user may be reluctant to change to meet the needs of the analyst. The fact that the analyst is, at best, a secondary user means that the likelihood of change is not high unless the operational user can be convinced of the pressing need for consistency.

The question for the analyst, then, is how to manage a situation in which most of the information is supplied by a computerized system that is not susceptible to change, where the demand is for immediate response, and where the analyst has little or no control over the information system which contains data of uneven quality.

Effective Institutional Research Operation

A key to effective institutional research analysis in this environment becomes the lines of communication that the analyst maintains, both to the data processing group and the operational system managers. To the extent that the analyst can make wishes known when system changes are contemplated, or to the extent that proposed changes to the system are reviewed by the analyst, the operational system can be modified so that the analyst can serve the executive more effectively. There is, however, a limited ability to change systems, in that the problems facing the executive change faster than systems can be changed. No matter how good the crystal ball of the analyst and executive the next iteration of a particular problem always seems to be slightly different from the last one. Thus, what was created to provide the appropriate information in the recent past is not quite satisfactory today.

Organizationally, the conflict between the needs of stable operational systems and the needs of the analyst has led to the almost mandatory "in-house" data processing capability in institutional reserach offices. Analyst-programmers, who are familiar with all of the operational systems, their data definitions, and the techniques for extracting and cross-matching data from several systems, often make the difference in answering executive questions. These analyst-programmers may have relatively little time for careful documentation, as desirable as that is, but they are expert at what have come to be known as "quick and dirty" programs. These are programs that quickly tell the analyst, for example, how many faculty would be affected by a proposed pay limitation from the National Science Foundation or how many entering freshmen came from high schools within commuting range of the institution.

Institutional researchers have to know how to work with imperfect data and to cross-check and reconcile data from competing sources. Differences between systems must be accounted for, and the analyst must be prepared to defend the particular data source chosen to answer the question. Defini-

tional differences between systems can be particularly important when the issue is one that will concern a variety of constituencies, since altering the definition may meet the needs of one group more than another.

Prospects for Change

Are there potential changes to information systems that are going to make the analyst's task easier? Information systems has been an area where the pace of technical change has been very rapid, and new developments have revolutionized processing and design requirements. Software and hardware changes have expanded the capability of information systems both in terms of size and speed. Perhaps the development of most potential use to the analyst will be the widespread adoption of easily used, on-line data base systems. To the extent that the institutional researcher can interact directly with the data, the problems of definition, timeliness, and lack of integration can be minimized. However, it would be easy, and probably misleading, to think that all problems are going to be solved by technological changes. There are several factors that suggest that data problems will be with us for some years to come: (1) there will be limited funds available for extensive adoptions of new systems or new hardware, given declining enrollments and relatively weakening state and federal support for higher education; institutions will have to maintain their existing systems for some time; (2) technological change has been oversold in the past as the answer to management problems. Higher education institutions are inherently complex organizations with uncertain goals and directions, operating in a relatively rapidly changing political and social climate. Any technological improvement, or new system or equipment feature, may answer management questions at the time it is installed. Yet, the institution will not remain static, and new needs will emerge.

Impact of State and National Systems

The discussion has focused on institutional information systems and the analyst as a user of institutionally generated information. A further important consideration is that of the effect of state and national information systems and their data bases on institutional research.

State and national systems present many of the same problems for institutional reserach offices as the institutional operational systems. The definitions required for the national reports may not be the same as those used internally, and reconciliation problems arise. Control of the larger system does not rest with the analyst, who can only be a user, adapting the data to his or her own needs. State and national data systems obviously broaden the opportunities for analysis, and make possible a much wider variety of comparative studies. Cross-institutional comparisons are of widespread interest but have many difficulties. Some nationally developed procedures, such as the NCHEMS Information Exchange Procedures, have attempted to define carefully a set of definitions and procedures within which uniform data can be exchanged. Since institutions vary widely in their organization and information systems, these procedures require careful, detailed study to be implemented. Even then, data comparisons may be difficult. Some of the more promising work in interinstitutional comparative data has been done by trying to understand the detailed structure of other institutions and then casting that information in terms that are relevant to the analyst's institution.

Planning and Management Systems

The special rigor of institutional research suggests that analysts and system designers should develop special purpose planning or executive data systems, designed to meet the needs of the analyst and institutional executive. These systems would have data consistently defined, integrated, and at a level of aggregation appropriate to the manager or analyst. They would draw from existing operational systems, but that data would be designed to answer the kinds of questions most often posed by the manager.

Such developments might well resolve a number of questions raised by the existing interface between operational systems and management needs, but experience suggests some caution. There are several reasons for this: Any planning or executive system that maintains records separate from an operational system will have reconciliation problems. The data items included will represent the analyst's and executive's view of what are important and relevant data at a given point in time. In a rapidly changing environment, it may not be possible to specify a set of categories general enough to encompass all of the problems that the executive or analyst will need to address in the coming years. Finally, the level of aggregation is very difficult to specify in designing such a system. In many cases, aggregated information is all that is needed, yet there are occasional cases where detailed information is required. Designing any one system to include both those levels may be duplicative and cumbersome.

The Role of the Institutional Research Office

Rather than designing the perfect planning information system, a more sensible alternative would be for institutional research offices to become the planning system. With a knowledgeable group of analysts and analyst-programmers and good access to institutional information systems, most one-time reports can be produced relatively rapidly. Then, after management review and consideration, additions can be designed. After several years of requests for comparative salary reports, for instance, a regular procedure may be instituted and reports produced at scheduled intervals. Frequent interaction with executives, as they define their own data needs, will insure that their needs are heard; changes can be made as circumstances and problems change.

What conclusions, then, can be drawn about the relationship between the institutional research function and information systems? Information systems, as they exist now within institutions and in state and national settings present significant problems to the analyst who must cope with less than adequate data. However, the systems have become so endemic that it is usually easier and cheaper to use existing systems and modify existing data than to begin anew. By knowing what is collected, including the detailed definitions and the methods by which the data are updated and checked, the analyst can decide how they should be adapted and modified to answer the policy questions. There is no substitute for knowledge of these systems in trying to provide analysis and data to institutional executives.

The institutional research office must also be involved in system review and development to reduce the problems involved in using the data in the future and to insure that management's needs for information can be satisfied.

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